PUTTING RESEARCH TO WORK BRIEF

A New Role for the Superpave Gyratory Compactor

Developed by the Strategic Highway Research Program and introduced in 1992, the Superpave mix design methodology is a performance-based system that considers environmental and traffic conditions in selecting asphalt binders and aggregates when designing asphalt mixtures and predicting performance. Superpave aims to improve hot-mix asphalt performance by limiting rutting, low-temperature cracking, and fatigue cracking.

Wisconsin and many other states use Superpave design criteria in HMA mixture design. A key tool in Superpave volumetric design is the Superpave Gyratory Compactor, which is used to compact mixture samples for volumetric analysis, recording density data throughout compaction. In a laboratory setting, the SGC simulates the roller compaction efforts used in the field better than previous equipment. Consolidation parameters for a specific mix can be used to estimate initial trafficking during construction and early service life, and rutting potential over a 20-year equivalent single axle load service life.

What's the Problem?

The SGC is currently being used to measure only volumetric properties—density or air void content as a function of compaction gyrations. Although obtaining volumetric properties is a necessary first step for high-quality HMA, mechanical properties are required for reliable prediction of HMA performance in the field. (The primary mechanical property of interest in projecting HMA service life is resistance to deformation—that is, rutting. Factors that impact rutting resistance include asphalt content, aggregate source and aggregate gradation.) Researchers are developing methods of measuring mechanical properties, but these will require new equipment and training in its use, and currently have limited market availability.

In addition, volumetric properties do not help designers estimate a mixture's workability, another mechanical property. Superpave mixtures for higher-traffic areas tend to be hard to compact; in Wisconsin, they generally require the use of special equipment or additional compaction rollers.

Research Objectives

Researchers' goal was to determine if SGCs already in use could also predict the mechanical stability of asphalt mixtures. They hypothesized that HMA mixture stability could be predicted from compaction parameters measured or estimated using the SGC.

To test their hypothesis, the research team aimed to correlate SGC densification data with measures of workability and rutting resistance, such as rutting rate or flow number. If such correlation was found, densification data gathered in the laboratory could then be used as screening criteria in selecting Superpave mixture designs for desired traffic levels.

Methodology

Researchers' tasks included:

• Performing a literature review to determine whether the SGC could potentially be used to measure or estimate mechanical properties such as resistance to rutting.

• Sampling several HMA mixtures produced using four different aggregate sources, two aggregate gradations for each source, and three levels of asphalt content.

• Compacting each mixture in the SGC to determine densification characteristics. Researchers also employed the new axial compression test developed by the National Cooperative Highway Research Program and used in the new AASHTO Mechanistic-Empirical Design Guide to evaluate rutting of the mixtures.

Investigator

"We found that you can use the gyratory compactor to look in a more technical way at constructability and the possible response of mixes to traffic loading."

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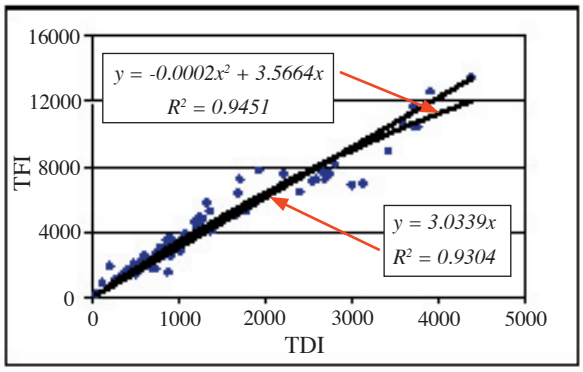

Researchers found a strong correlation between the traffic densification index, which can be calculated with data from the Superpave Gyratory Compactor (above left), and the traffic force index, which is measured with an additional pressure plate accessory (Fig. 4.22 of the final report). These indices correlate well to a mixture's mechanical stability.

• Correlating densification measured by the SGC to various construction and traffic indices. Researchers then compared these relationships to rutting results from the axial compression test in order to identify correlations between rutting characteristics and the indices.

Results

The SGC appears to yield information that can be used to characterize mixture stability. The literature review confirmed that the SGC showed promise for measuring mechanical properties—that the data collected during compaction by the SGC can be used to evaluate stiffness and rutting resistance of HMA design mixtures.

Because the SGC data can be used to calculate traffic indices, which correlate well to mechanical properties indicated by flow number and rate of rutting, it can therefore be used to estimate resistance to rutting. Researchers were able to establish correlations regardless of aggregate structure, source or asphalt content.

Implementation and Benefits

WisDOT can now use the SGC as an initial screening device to assess the mechanical stability of mix designs for various traffic levels, and to project their performance. This new capability requires no new tools, thereby avoiding equipment acquisition and training costs.

Hence, the SGC can be employed both in current procedures for assessing mix densification, and in a new process, at no additional cost, for anticipating workability and rutting resistance. Better, more durable HMA designs should follow.

Further Research

Investigators noted that this research involved a limited number of samples and use of one SGC unit. The results warrant further tests using a wider range of mixtures and mix design variables, including more asphalt binder grades. Researchers recommend conducting additional testing using other SGC models to evaluate repeatability of the results for different equipment. Future research should also develop correlations between laboratory and field data.

This brief summarizes Project 0092-01-02, "Using the Gyratory Compactor to Measure Mechanical Stability of Asphalt Mixtures," produced through the Wisconsin Highway Research Program for the Wisconsin Department of Transportation Research, Development & Technology Transfer Program, 4802 Sheboygan Ave., Madison, WI 53707.

Nina McLawhorn, Research Administrator

Project Manager

"The information produced by the SGCs tells us something mechanically, rather than just volumetrically, about the mixture, and has the potential to help us differentiate between mixtures using stiffness parameters."

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